

CLAIMS:

1. A spot-size transformer comprising:

a first optical waveguide having a first core and a first cladding covering substantially the whole surface of the first core;

5 a second optical waveguide having a second core provided as an extension of the first cladding and a second cladding;

a transition waveguide positioned between the first and second optical waveguides;

10 the transition waveguide having a first core whose width of the extension becomes gradually narrower as it goes toward the second optical waveguide.

2. The spot-size transformer in accordance with claim 1, wherein each of the first optical waveguide and the second optical waveguide is channel-type.

15 3. The spot-size transformer in accordance with claim 2, wherein the center of the first core and the center of the second core are positioned substantially on the same axis.

4. The spot-size transformer in accordance with claim 3, wherein the first
20 cladding has at least a lower cladding positioned under the first core and an upper cladding positioned above the first core.

5. The spot-size transformer in accordance with claim 4, wherein the bottom
of the first core is in contact with the lower cladding and the top surface and the
25 both sides of the first core are in contact with the upper cladding.

6. The spot-size transformer in accordance with claim 5, wherein the end face

of the second core is substantially rectangular.

7. The spot-size transformer in accordance with claim 1, wherein the section with the first cladding and the part constituting the second core that is an
5 extension thereof substantially perpendicular to the axis are rectangular.

8. The spot-size transformer in accordance with claim 2, wherein the section with the first cladding and the part constituting the second core that is an extension thereof substantially perpendicular to the axis are rectangular.

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9. The spot-size transformer in accordance with claim 3, wherein the section with the first cladding and the part constituting the second core that is an extension thereof substantially perpendicular to the axis are rectangular.

15 10. The spot-size transformer in accordance with claim 4, wherein the section with the first cladding and the part constituting the second core that is an extension thereof substantially perpendicular to the axis are rectangular.

11. The spot-size transformer in accordance with claim 5, wherein the section
20 with the first cladding and the part constituting the second core that is an extension thereof substantially perpendicular to the axis are rectangular.

12. The spot-size transformer in accordance with claim 6, wherein the section with the first cladding and the part constituting the second core that is an
25 extension thereof substantially perpendicular to the axis are rectangular.

13. The spot-size transformer in accordance with claim 12, wherein the first

core has a shape obtained by omitting the end of the part that becomes gradually narrower.

14. The spot-size transformer in accordance with claim 13, wherein the second
5 cladding is formed of a ladder silicone.

15. The spot-size transformer in accordance with claim 13, wherein the second cladding is formed of a silica glass.

10 16. The spot-size transformer in accordance with claim 15, wherein the second cladding is formed using a thin film process selected from a group consisting of a CVD process, a sputtering process, a vacuum deposition process, a FHD process and a sol-gel process.

15 17. A spot-size transformer comprising:

a first optical waveguide having a first core and a first cladding covering the first core;

a second optical waveguide having a second core and a second cladding covering the second core;

20 a transition waveguide which is positioned between the first and the second optical waveguide;

wherein a light propagated into the first waveguide has a first optical field distribution;

a light propagated into the second waveguide has a second optical field
25 distribution;

the transition waveguide changes from the first optical field to the second optical field gradually or changes from the second optical field to the first optical

field gradually; and

the second core covers the first core at least in the part corresponding to the transition waveguide and includes the region where a refractive index is changed by irradiating energy beam.

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18. The spot-size transformer in accordance with claim 17, wherein the width of the part of the first core correspond to the transition waveguide becomes gradually narrower as it goes toward the second optical waveguide.

10 19. The spot-size transformer in accordance with claim 18, wherein the part of at least the first cladding is provided as the extension of the second core.

20. The spot-size transformer in accordance with claim 19, the second cladding has a first part which comprises substantially non-doped silica glass and a
15 second part which comprises silica glass containing at least germanium (Ge).

21. The spot-size transformer in accordance with claim 20, the second part further contains a first element which reduces refractive index.

20 22. The spot-size transformer in accordance with claim 21, the refractive indexes of the first part and the second part are substantially equal.

23. The spot-size transformer in accordance with claim 22, the first core comprises a material in which at least germanium (Ge), a first element and a
25 second element which raise its refractive index are contained in the silica glass.

24. The spot-size transformer in accordance with claim 23, the first element is

boron (B) and the second element is phosphorus (P).

25. The spot-size transformer in accordance with claim 24, the first optical waveguide and the second optical waveguide are channel-type and the center of the first core and the second core are located approximately on the same axis.

26. A waveguide-embedded optical circuit comprising:
each of the first spot-size transformer and the second spot-size transformer including at least a first optical waveguide having a first core and a first cladding,
10 a second optical waveguide having a second core which is provided as the extension of the first cladding and a second cladding;

the second optical waveguide of the first spot-size transformer and the second optical waveguide of the second spot-size transformer, which face each other through a groove.

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27. The waveguide-embedded optical circuit in accordance with claim 26, wherein further comprising an optical functional element which is inserted in the groove.

20 28. The waveguide-embedded optical circuit in accordance with claim 27, wherein each of the first spot-size transformer and the second spot-size transformer comprises a transition waveguide which is positioned between the first and the second optical waveguide, the transition waveguide having the first core whose width of the part becomes gradually narrower as it goes toward the
25 second optical waveguide.

29. The waveguide-embedded optical circuit in accordance with claim 28,

wherein the first cladding covers substantially the whole surface of the first core.

30. The waveguide-embedded optical circuit in accordance with claim 28,
wherein the center of the first core and the center of the second core are
5 positioned substantially on the same axis.

31. The waveguide-embedded optical circuit in accordance with claim 30,
wherein the second cladding is formed of a ladder silicone.

10 32. The waveguide-embedded optical circuit in accordance with claim 30,
wherein the second cladding is formed of a silica glass.

33. The waveguide-embedded optical circuit in accordance with claim 32,
wherein the second cladding is formed using a thin film process selected from a
15 group consisting of a CVD process, a sputtering process, a vacuum deposition
process, a FHD process and a sol-gel process.

34. A waveguide-embedded optical circuit comprising a pair of the spot-size
transformer in accordance with the claim 25, the second optical waveguide of one
20 spot-size transformer and the second optical waveguide of other spot-size
transformer, which face each other through a groove.

35. The waveguide-embedded optical circuit in accordance with claim 26,
wherein further comprising an optical functional element which is inserted in
25 the groove.

36. A method of producing a spot-size transformer which comprises a first

optical waveguide, a second waveguide and a transition waveguide positioned between the first optical waveguide and the second optical waveguide, which method comprising the steps of;

5 forming a region of the core corresponding to the part of the first optical waveguide and the transition waveguide;

forming a cladding layer covering at least the region of the second optical waveguide and the transition waveguide; and

10 changing the refractive index gradually by projecting high-energy beam onto at least a part of the cladding layer corresponding to the transition waveguide and the second optical waveguide.

37. A producing method of the spot-size transformer in accordance with claim 36, the step of forming the region of the core comprises the steps of:

15 forming a core layer;
patterning the core layer so that the width of the core layer is substantially constant in the part corresponding to the first optical waveguide and becomes gradually thinner as it goes toward the second optical waveguide in the part corresponding to the transition waveguide.

20 38. A Producing method of the spot-size transformer in accordance with claim 37, the region in which the refractive index is changed by irradiation with the high-energy beam composes the core of the second optical waveguide and at least a part of the cladding of the first optical waveguide.